SOME NEW APPARATUS.

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In the last number of this *Journal* I described some apparatus for demonstration and class experiments.[1] Certain pieces were not completed at the time when that paper was written; so that I was not able to give illustrations. My present purpose is to make good this deficiency.

The accompanying half-tone plate shows four large apparatus, to which reference was made in my former paper.

1. *The new model Whipple gasometer.* The double gasometer for acoustic and general laboratory work was described and figured by Dr. Whipple in this *Journal*, XIV, 1903, 107 ff. A new model of the instrument is shown to the left of the accompanying plate. It has been rendered more compact, by the substitution of a metal for the original wooden frame. It has been mounted on a wheeled platform, so that it can be moved from room to room of the laboratory. Outlet cocks have been soldered into each tank, near the floor, so that the water can be drawn off and the apparatus correspondingly lightened for moving. The butterfly valves are encased, not in wooden boxes, but in felt-lined brass tubes. These can readily be taken apart if anything goes wrong with the flaps. Minor improvements have been introduced as regards the lateral guidance of the moving tanks, the overhead travelling of the chain, and the raising and shifting of the counterweight.

There is thus no change in principle, though the apparatus as a whole is a good deal more serviceable than it was in its first form. I may add that our inner stationary tanks have shown a tendency to rust into holes. We have learned wisdom by experience, and now keep some borax in solution in the contained water. The mending of a tank is, at best, an awkward business, and means the dismantling of at least half the apparatus.

2. *The frame for adaptation and after-images.* This is seen standing on the platform, to the right of the gasometer. The plate shows the frame in readiness for an experiment. The black-white sheet drops down, as was explained in my former paper, behind the black front, and exposes a gray sheet upon which the complementary after-images are seen.

[1] Commemorative Number, 175 ff; XIV, 1903, 439 ff.

3. *The contrast frame.* This is shown in place, upon the wall behind the lecturer's desk. The four colored papers are, from left to right, the Hering red, green, blue, and the Milton Bradley yellow. The gray strip is cut from Hering's gray paper, no. 11. The tissue paper front can be turned up, the colored papers and gray strip exposed, and the strip removed from the frame.

4. *The six-fold color mixer.* The mixer is also shown in place, upon the desk. The mechanism will be understood by reference to Fig. 1, which represents the parts at a quarter of their actual size.

a is the main frame of the mixer made of cast iron. This is

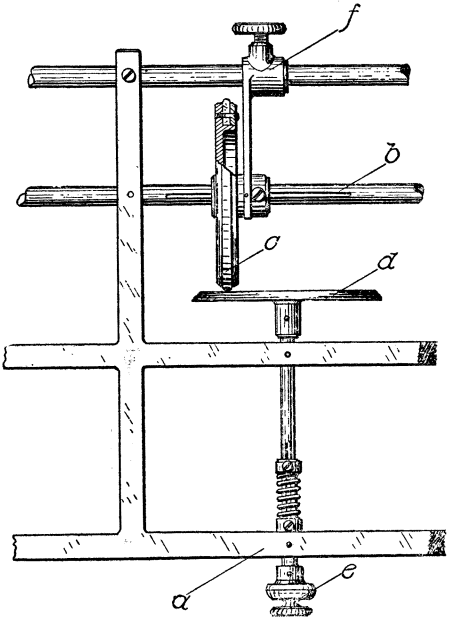

FIG. 1.

Detail of Color Mixer.

the cheapest material; and, with care, a good casting may be made. *b* is the main driving shaft, of wrought steel. It is driven by a motor, whose belt passes over the pulley shown at the extreme left of the instrument in the plate: the pulley may, of course, be placed at the center of the shaft, and the motor concealed beneath the lecturer's table, if desirable. The shaft carries *c*, the driving friction disc. This is made of alzinc, faced with leather. It actuates the driven friction disc, *d*, which is also of alzinc. It will be noticed that *d* tapers off at

the periphery, so that *c* can be brought on gradually, and metal strikes metal before the leather comes into action. As *d* turns, the spindle, carrying the clamp *e* for the colored papers, turns with it. *f* is the shifter, by means of which *c* can be set at any point upon the surface of *d*, or thrown off altogether. The remaining details of construction will be clear from the figure. It is evidently possible, while *b* is turning at a constant speed, to rotate the six color discs all at once at the same or at different speeds, or to rotate any one or more while the rest remain unmoved. The wooden base of the instrument stands upon a thick layer of felt, and the motor is set upon felt and boxed in: the noise may thus be reduced to a minimum. Even under the unfavorable conditions of my own lecture room — the desk acts as a resonance chamber, and the platform is built over a stairway and so acts as another — it is possible to continue lecturing, without strain of the voice, while the mixer is turning. The motor which we employ is a 1/6 H. P. Crocker-Wheeler; a less powerful motor would answer as well.

5. *The wall campimeter.* This is not shown in the plate. I mention it again because, by some fatality, the dimensions were wrongly given in my previous paper.[1] A strip of 2 m. in length, as seen from some parts of the lecture room, would serve only to take the stimulus a short distance beyond the macular region. The strip is, in reality, 12 m. long; the stimuli are discs, 20 cm. in diameter; there are three fixation crosses, two at the two ends and one at the center of the strip. The best results are obtained with a dark violet disc, which shows in the blue-yellow zone as a hard, staring blue, and a bright reddish brown, which shows in the same zone as a clear yellow.

The apparatus could easily be made permanent. I would suggest two vertical spring rollers, fastened to the wall at either end of the lecture room, and carrying each 6 m. of cloth; and a permanent wire, to be tightened by a ratchet, extending across the wall for the support of the upper edge of the cloth. The two strips of cloth could be hooked together where they meet, over the center of the blackboard; a draw-string along their lower edge would prevent curling. It would also be easy to devise a stimulus carriage, which should travel along wires from end to end of the cloth, and be operated from a single point by the lecturer. I doubt, however, from the partial estimates that I have so far made, whether the apparatus would be worth its cost. The manila strip, and the rod and disc in the hands of an itinerant lecturer, satisfy all requirements.

6. *A disc cutter.* I mentioned in my former paper that we

[1] *Ibid.*, 185; XIV, 449.

have used, to construct color discs, two discs of copper, turned accurately to the right size, and pierced at the center. The paper is laid between the copper discs, which are clamped together, and is trimmed round the edge with scissors.[1] I found at the beginning of the current academic year that the copper discs had suffered a good deal from student usage; their edges were flattened and dented. It therefore seemed worth while to make a different and less damageable apparatus for disc cutting. We now employ the instrument shown, quarter size, in Fig. 2.

e is a circular base of hard wood. Upon it is screwed an aluminium disc, *a*, of the same size. The base is pierced at the

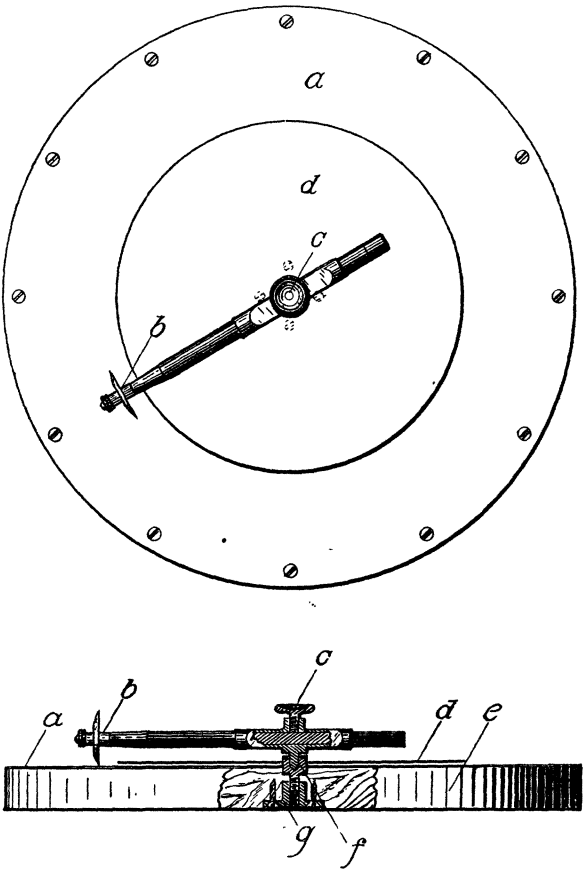

FIG. 2.
Disc Cutter.

[1] *Ibid.*, 182; XIV, 446.

center by a screw post, *f*, which is held below by a split nut *g*. The top of the screw post is hollowed to receive a boss from the cross-arm which carries the knife, *b*, of tempered steel. The knife can be set for any required radius; the arm is held in place by the cup screw *c*. *d* is a loose disc of aluminium, fitting over the top of the screw post.

The top of the screw post is of the same diameter as the *large-sized* central holes of the Hering or Zimmermann discs. When a disc of this sort is to be cut, the paper is roughly shaped with scissors, and the central hole punched out. The paper is then laid on *a*; *d* is laid over the paper; the cross-arm is put in place, with *b* at the right distance from the center; and arm and knife are turned from *c*. The disc *d* serves to hold the paper flat for cutting. The boss that extends into the head of the screw post is of the same diameter as the *small-sized* central holes of the imported discs. When a disc of this sort is to be cut the paper is shaped and the center punched, as before. Then *f* is turned down flush with the surface of *a* (there is a slot in the head of the screw post not shown in the Fig., which takes the screw driver); the paper is laid over *a*; a small-holed *d* is laid over the paper; the boss passes down through *d* and paper into the head of *f*; and the cutting is done as before. It is thus necessary to have four *d*; two large, with large and small central holes, and two small, with similar holes. The instrument is cheap, strong and simple, and ought to last longer than the copper discs.

All the pieces here mentioned were made by Mr. F. A. Stevens, the mechanician of the Cornell laboratory. I am indebted to Mr. Stevens for many improvements of design and for suggestions as regards details of construction.